Thank You for the Invitation...

UMass Extension's Green School

David Bloniarz, USDA Forest Service
Northern Research Station
Amherst, Massachusetts
i-Tree Overview

Assessing the value of urban trees
Today’s Session

• Introduction
• Urban Forests in Context
• What is i-Tree: General Overview
• i-Tree Components & Tools
• Choosing the correct i-Tree Tool
• Conducting an i-Tree Project
• Review and Questions
i-Tree Overview
Assessing the value of urban trees

www.unri.org/research-documents
Urban Forests & Tree Canopy

Annapolis, MD
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Worcester, MA
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What is i-Tree?

A suite of tools to assess urban vegetation and their ecosystem services and values

i-Tree Eco = UFORE v. 3.0 programs
Public-Private Partnership

- USDA Forest Service
- Davey Tree Expert Co.
- National Arbor Day Foundation
- Society of Municipal Arborists
- International Society of Arboriculture
- Casey Trees
Goals

简单的低成本工具和方法，以协助城市森林规划和管理

完整的流程 – 从始至终
Assessing Tree Populations

i-Tree assesses:

- **Structure**
- **Function**
  - Energy use
  - Air pollution
  - Carbon
  - VOC emissions
- **Value**
- **Management needs**
  - Pest risk
  - Tree health
  - Exotic/invasive spp.
The Foundation: Local Data

Local Sample or Inventory

Local information:
- Weather
- Pollution
- Environmental variables

Hourly simulations
Benefit-Based Approach

i-Tree Tools

Structure

Environmental Services

Comprehensive Value

Strategic Management & Advocacy
Conserving Energy

Image courtesy of the Center for Urban Forest Research
Improving Air Quality

Image courtesy of the Center for Urban Forest Research
Reducing Atmospheric Carbon Dioxide

Image courtesy of the Center for Urban Forest Research
Reducing Stormwater Runoff

Image courtesy of the Center for Urban Forest Research
i-Tree is...

Development, Dissemination, Support, & Refinement

- Credible, USDA FS peer-reviewed tools
- Public Domain Software
- Accessible
- Technical Support

“Putting USFS Urban Forest science into the hands of users”
i-Tree: the early years
What’s being used?

i-Tree Eco

i-Tree Streets
i-Tree Utilities:
NFL favors proven strategies for a green Super Bowl

Tampa Bay Business Journal - by Alexis Mueller Editor

Real carbon impacts
To that end, for the first time at a Super Bowl, the U.S. Forest Service is implementing in Tampa a public domain software monitoring system called i-Tree that it developed with Kent, Ohio-based Davey Tree Expert Co. The software, its components 10 years in the making, is expected to do a far more accurate job of monitoring the carbon impact of the tree-planting efforts than current systems offer.
i-Tree Use

Program distribution increasing about 25% per year

Distributed to over 90 countries
April 18, 2007

Maybe Only God Can Make a Tree, but Only People Can Put a Price on It

- Climate change
- Storm water mgt.
- Pollution mitigation
- Energy conservation
- Carbon strategies
- Economic development
- Green job creation
- Public health issues
"Instead of spending money planting trees on a causeway, we should fix the bridge on the causeway,"...

--Senator Tom Coburn (R-OK)
Using technology to tell your story?

Credit: Waldo Nilo
Successful storytelling with i-Tree requires:

1. Understand your Vision
2. Plan & Implement Strategically
3. Turn your results into a compelling message
4. Make a difference
i-Tree: Demonstrating That Trees Pay Us Back!

Street Tree Benefits in Minneapolis:

- $6.8 million in energy savings
- $9.1 million in reduced storm water runoff
- $7.1 million increase in property value
- $1 million improvements to air quality
The City of Kirkland has given each tree along Park Lane a report card and some of them are not doing so well. The report cards state that the city is “working to restore, enhance…"
How do we communicate the value of community trees?

“Shame on you City of Kirkland! Government has too much money if we can afford to grade trees!”
$2.94 in benefits for every $1 spent

Benefit Summary for Pittsburgh’s Street Trees

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Total ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>$1,205,133</td>
</tr>
<tr>
<td>CO2</td>
<td>$35,424</td>
</tr>
<tr>
<td>Air Quality</td>
<td>$252,935</td>
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<tr>
<td>Stormwater</td>
<td>$334,601</td>
</tr>
<tr>
<td>Aesthetic/Other</td>
<td>$572,882</td>
</tr>
<tr>
<td><strong>Total Benefits</strong></td>
<td><strong>$2,400,975</strong></td>
</tr>
</tbody>
</table>
Key Element for Success #1: Understand Your Vision for Using the Results

Knowing why you are implementing i-Tree and specifically what you want out of it.

- Credibility
- Quantification using sound science

“Trees are a favorite tool because every tree intercepts about 1,400 gallons of rainfall”

--Danielle Crumrine
i-Tree – General Project Phases

Phase I: Getting Started
- Study area, inventory type

Phase II: Project Establishment
- Project parameters, mobilization

Phase III: Out in the Field
- Data collection, Management

Phase IV: Running the Software
- Reporting, interpretation
Chestertown, MD: linking technology with policy

Chestertown Goes Green

- Energy: $31,280
- Carbon: $7,760
- Air quality: $8,287
- Stormwater: $83,413
- Property: $103,020

Total annual benefits: $223,750
Chestertown i-Tree Project Details

- **Project expenses**: $2,000 approx.
- **Funding assistance**: Chesapeake Bay Trust grant
- **Key Partner**: Washington College- CES
- **Project manager**: Local resident (retired forester)
- **Inventory type**: 15% random sample
- **Data collection**: 40 students & trained vols.
- **Data collection**: 3 - Days
- **Total project time**: Approx. 3 months
Key Element for Success #2: Plan & Implement Strategically

- Understand the advantages and limitations of i-Tree
- Assess your capacity to complete a project
- Identify barriers and how you will address these
- Develop an implementation plan, but stay flexible

Tree Ordinance Takes a Whack
Posted by John Lang on September 8, 2009 • 5 Comments

If you’ve got a great big old tree in your yard in Chestertown and you don’t like it for any reason, just chop it down, no approvals necessary. There’s no such tree protection in the town ordinance anymore.
EAB Structural Impacts:

17.4% Canopy Loss

$221 Million structural damage (citywide)

EAB Functional Impacts:

- $243,785 less pollutant removal
- $138,000 less energy savings (cooling costs)
- $2.6 million reduction in storm water benefits (1996 study)
Milwaukee Ecosystem Assessment
Key Element for Success #3: Make the message compelling.

- Craft your message for your intended audience
- Make local, tangible connections
- Link tree benefits to themes and current initiatives
GOAL: Reduce global warming pollution levels to 7 percent below 1990 levels by 2012.

U.S. Conference of Mayors, Climate Protection Agreement
Detailed, Species Specific Data

Table 13. Net Atmospheric CO₂ Reduction by Chattanooga’s Street Trees—City-Managed Population Only

<table>
<thead>
<tr>
<th>Species</th>
<th>Sequestered (lb)</th>
<th>Sequestered ($</th>
<th>Net Total (lb)</th>
<th>Total ($)</th>
<th>SE</th>
<th>% of Total Tree Numbers</th>
<th>% of Total $</th>
<th>Avg. $/tree</th>
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<tbody>
<tr>
<td>hackberry</td>
<td>2216030</td>
<td>2419.11</td>
<td>4041645</td>
<td>30,312.34</td>
<td>(±5,126)</td>
<td>10.8</td>
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<td>flowering dogwood</td>
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<td>2419.11</td>
<td>798960</td>
<td>5,992.20</td>
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<td>6.9</td>
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<td>0.52</td>
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<td>black cherry</td>
<td>1132161</td>
<td>836.32</td>
<td>1398996</td>
<td>10,492.47</td>
<td>(±2,031)</td>
<td>4.5</td>
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<td>mimosa</td>
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<td>322339</td>
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<td>311476</td>
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<td>(±712)</td>
<td>3.6</td>
<td>0.9</td>
<td>0.39</td>
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<td>slippery elm</td>
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<td>1196.32</td>
<td>492663</td>
<td>3,952.24</td>
<td>(±802)</td>
<td>1.4</td>
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<td>0.28</td>
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<td>red maple</td>
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<td>333692</td>
<td>2,617.47</td>
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<td>Yoshino flowering</td>
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<td>totobity pine</td>
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<td>1074.14</td>
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<td>chestnut oak</td>
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<td>4766.76</td>
<td>1278419</td>
<td>9,588.14</td>
<td>(±2,492)</td>
<td>1.7</td>
<td>3.8</td>
<td>3.46</td>
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<td>white ash</td>
<td>412870</td>
<td>3097.27</td>
<td>119856</td>
<td>9,685.83</td>
<td>(±1,849)</td>
<td>6.9</td>
<td>2.4</td>
<td>0.52</td>
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<td>Chinese elm</td>
<td>572308</td>
<td>4292.31</td>
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<td>(±1,849)</td>
<td>6.9</td>
<td>2.4</td>
<td>0.52</td>
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<td>southern red oak</td>
<td>547883</td>
<td>1653.07</td>
<td>822646</td>
<td>6,450.86</td>
<td>(±1,849)</td>
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<td>black tupelo</td>
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<td>4292.31</td>
<td>119856</td>
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<td>(±1,849)</td>
<td>6.9</td>
<td>2.4</td>
<td>0.52</td>
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<td>Other street trees</td>
<td>6645139</td>
<td>49,838.54</td>
<td>8152155</td>
<td>61,494.11</td>
<td>(±6,623)</td>
<td>21.2</td>
<td>24.5</td>
<td>1.75</td>
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<td>Citywide Total</td>
<td>27026224</td>
<td>$207,151.70</td>
<td>$1110142</td>
<td>$8,404.06</td>
<td>100.0</td>
<td>$527,293.50</td>
<td>$33401542</td>
<td>$250,901.59</td>
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</table>

- Average CO₂ reduction = 200 lbs
- Average tree maintenance costs = $3.46
- Cost of CO₂ reduction = $35 per ton
- 25% of Carbon emissions offset by municipal trees
Springfield Massachusetts
June 1, 2011 Tornado
Springfield Massachusetts
June 1, 2011 Tornado

Northern Research Station
USDA Forest Service
Informational Brief

June 23, 2011

Kipling Street
East Forest Park
Springfield, MA

Tornado Damage Quick Facts

Impacts on Springfield’s Street Trees

On June 1, 2011, a series of three tornadoes ripped through Western Massachusetts, and included the second strongest tornado ever recorded in Massachusetts, with wind speeds estimated at 136 to 161 mph, according to the National Weather Service. The most severe tornado was the EF-3, on the Enhanced Fujita Damage Classification Scale, that carved a half-mile-wide path for 19 miles from Westfield to Chicopee, killing three people and injuring 200. In Springfield, the tornado impacted city’s South End, the Corners, East Forest Park and sixteen Acres neighborhoods.

In the neighborhoods of Springfield affected by the storm, damage to the street trees was extensive, destroying or severely many of the public trees growing in these areas. A team of US Forest Service and City of Springfield personnel conducted a preliminary review of the streets in these neighborhoods, and an initial summary of the storm impacts was developed.

A preliminary review of the storm damage to Springfield public street trees follows here:

- 32 miles of the 240 total miles of city streets were impacted by the storm.
- 16.1% of Springfield’s streets showed some damage to the public trees growing on them.
- Approximately 1,140 of the 8,810 streets trees, growing in the impacted areas, were destroyed or severely damaged, necessitating removal.
- Immediate impacts include the reduction of rainwater interception by 2,444,312 gallons.
- Reduced storage of 7,322,861 pounds of carbon.
- Approximately 53,112 pounds of sequestered CO2 has been lost.

For more information please contact:

David Y. Bloniarz
US Forest Service Northern Research Station
Amherst, MA
https://www.fs.fed.us

Alexander R. Sherman
City of Springfield
Assistant City Forester
arshema@eco.mass.edu
## Annual Benefits of Impact Zone Street Trees

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Quantity</th>
<th>Impact Zone Value</th>
<th>Loss Value</th>
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<tbody>
<tr>
<td><strong>Energy Saved</strong></td>
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<td></td>
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<tr>
<td>Electricity (MWh)</td>
<td>360.6</td>
<td>$18,393</td>
<td>$4,598</td>
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<td>Natural Gas (therms)</td>
<td>129,018.6</td>
<td>$85,439</td>
<td>$29,903</td>
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<tr>
<td>Total ($)</td>
<td></td>
<td>$103,832</td>
<td>$34,501</td>
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<tr>
<td><strong>Carbon Dioxide</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>CO$_2$ Sequestered (lbs)</td>
<td>946,377</td>
<td>$3,123</td>
<td>$1,093</td>
</tr>
<tr>
<td>CO$_2$ Released (lbs)</td>
<td>-244,714</td>
<td>-$808</td>
<td>-$283</td>
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<tr>
<td>CO$_2$ Avoided (lbs)</td>
<td>1,086,259</td>
<td>$3,585</td>
<td>$1,255</td>
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<tr>
<td>Total (lbs, $)</td>
<td>1,787,922</td>
<td>$5,900</td>
<td>$2,065</td>
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<tr>
<td><strong>Air Quality</strong></td>
<td></td>
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<tr>
<td>Avoided pollutants* (lbs)</td>
<td>4954</td>
<td>$21,451</td>
<td>$7,508</td>
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<td>Deposited pollutants** (lbs)</td>
<td>4264</td>
<td>$22,958</td>
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<td>BVOC emitted (lbs, $)</td>
<td>-1,140</td>
<td>-$2,634</td>
<td>-$922</td>
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<tr>
<td>Total (lbs, $)</td>
<td>8,078</td>
<td>$41,775</td>
<td>$14,621</td>
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<td><strong>Storm Water</strong></td>
<td></td>
<td></td>
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<tr>
<td>Rainfall intercepted (gal)</td>
<td>6,983,576</td>
<td>$55,872</td>
<td>$19,555</td>
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<td><strong>Aesthetic/Other</strong></td>
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<td>Added Property Value</td>
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<td>$140,569</td>
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<td><strong>TOTAL VALUE</strong></td>
<td>$347,948</td>
<td>$121,782</td>
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*NO$_2$, SO$_2$, VOC, PM$_{10}$  **O$_3$, NO$_2$, PM$_{10}$, SO$_2$
An Initial Report on the Status of Street Trees in Springfield, Massachusetts

Tornado Damage to Springfield’s Street Trees
June 2011

prepared for:
The City of Springfield, Massachusetts

prepared by:
Alex Sherman, City of Springfield
Rob Dill, City of Springfield
Edward Casey, City of Springfield

David V. Bionarz, USDA Forest Service
Northern Research Station
Tornado Damage Quick Facts
Impacts on Springfield’s Urban Forest

On June 1, 2011, a series of three tornadoes ripped through Western Massachusetts, and included the second strongest tornado ever recorded in Massachusetts, with wind speeds estimated at 135 to 155 mph, according to the National Weather Service. The most severe tornado was the EF-3, on the Enhanced Fujita Damage Classification Scale, that carved a half-mile wide path for 39 miles from Westfield to Charlton, killing three people and injuring 300. In Springfield, the tornadoes impacted city’s South End, Six Corners, East Forest Park andSixteen Acres neighborhoods.

In the neighborhoods of Springfield affected by the storms, damage to the urban forest canopy was extensive, destroying or severely damaging many of the trees growing in these areas. A team of US Forest Service and City of Springfield personnel conducted a preliminary review of the streets in the impacted neighborhoods, and utilized i-Tree modeling software to analyze the impacts of the storms on the urban forest, and an initial summary of the damage was developed.

A preliminary review of the storm damage to Springfield’s urban tree canopy follows here:

- Based on initial estimates, over 13,000 trees were destroyed or severely damaged;
- Immediate impacts include the reduction of rainwater interception by over 7.5 million gallons per year;
- Reduced storage of over 30 million pounds of carbon annually;
- Approximately 1.4 million pounds of sequestered CO₂ has been lost.

For more information please contact:

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City of Springfield
Assistant City Forester
asherman@co.springfield.ma.us
i-Tree Canopy Analysis of Springfield Tornado Zone

• Over 13,000 trees were destroyed or severely damaged;
• Immediate impacts include the reduction of rainwater interception by over 7.5 million gallons per year;
• Reduced storage of over 30 million pounds of carbon annually;
• Approximately 1.4 million pounds of sequestered CO2 has been lost.
The June 2011 Massachusetts tornado profoundly altered the landscape over a wide geographic area. On June 1, 2011 a series of tornadoes ripped through western Massachusetts, and included the second strongest tornado ever recorded in Massachusetts, with wind speeds estimated at 156 to 160 mph, according to the National Weather Service. The most severe tornado was the EF-3, on the Enhanced Fujita Damage Classification Scale, that carved a half-mile-wide path for 89 miles from Westfield to Churton, killing three people and injuring 200. In Springfield, the tornadoes impacted city’s South End, Upper Hill, Metro Center, Six Corners, East Forest Park and Sixteen Acres neighborhoods.
Key to Success # 4: Make a difference

- Share your results strategically with numerous audiences in multiple formats
- Teach others how trees can be part of the solution to THEIR problem
i-Tree Version 4.0

- 5 New or Enhanced Tools

- Hydro
- Vue
- Canopy
- Pest
- Design
Pest detection Protocol

- Component of Streets in i-Tree v.4.0

- Collect Pest & Disease
  - Signs
  - Symptoms

- Reports
  - Associated pest & diseases
  - Trends/patterns
Remote Sensing Canopy Assessment Tools

- **Satellite Based**
  - i-Tree Vue

- **Statistical Estimation via photo-interpretation**
  - i-Tree Canopy

- **Hyperspectral classification, GIS analysis, and photo-interpretation**
  - UTC

Cost, Resolution, Time

- less
- more
i-TREE Benefit Calculator

Overall Benefit

Storm Water  Energy  Air Quality  CO2

$4.00  $67.19
$71.15  $6.52
$13.93

Breakdown of your tree's benefits

This 21 inch Northern pin oak provides overall benefits of: $160 every year.

While some functional benefits of trees are well documented, others are difficult to quantify (e.g., human social and communal health). Trees' specific geography, climate, and interactions with humans and infrastructure is highly variable and makes precise calculations that much more difficult. Given these complexities, the results presented here should be considered initial approximations—a general accounting of the benefits produced by urban street-side plantings.

Benefits of trees do not account for the costs associated with trees' long-term care and maintenance.

If this tree is cared for and grows to 26 inches, it will provide $195 in annual benefits.

Northern pin oak (Quercus ellipsoidalis)
Vue – Estimates Ecosystem Services from National Cover Maps and Google Maps
Classify random points
Remember, the more points you survey, the lower your Standard Error, and the more precise your sampling will be. More points surveyed provide for a better estimation of Land Cover across your study area.

Save Your Data

Save Data  Save Early. Save Often. Don't lose your project data!
i-Tree Canopy Cover Report

Percent Cover (±SE)

<table>
<thead>
<tr>
<th>Cover Class</th>
<th>Description</th>
<th>Abbr.</th>
<th>% Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree</td>
<td>tree, non-arb.</td>
<td>T</td>
<td>34.3 ±0.8</td>
</tr>
<tr>
<td>Grass</td>
<td>herbaceous ground cover</td>
<td>Gr</td>
<td>8.96 ±3.66</td>
</tr>
<tr>
<td>Impervious</td>
<td>artificial surfaces</td>
<td>Imp</td>
<td>44.3 ±3.66</td>
</tr>
<tr>
<td>Bare Ground</td>
<td>soil or barren</td>
<td>BG</td>
<td>7.46 ±3.34</td>
</tr>
<tr>
<td>Shrub/Scrub</td>
<td>non tree woody/land cover</td>
<td>SS</td>
<td>0.09 ±0.00</td>
</tr>
<tr>
<td>Agriculture</td>
<td>crops, pasture, hay</td>
<td>Ag</td>
<td>0.09 ±0.00</td>
</tr>
<tr>
<td>Water</td>
<td>lakes, streams</td>
<td>W</td>
<td>4.48 ±2.59</td>
</tr>
<tr>
<td>Other</td>
<td>other land cover</td>
<td>O</td>
<td>0.09 ±0.00</td>
</tr>
</tbody>
</table>

About i-Tree Canopy
The concept and prototype of this program were developed by David J. Nowak, Jeffrey T. Walton and Eric J. Greenfield (USDA Forest Service). The current version of this program was developed and adapted for i-Tree by David Ellingsworth, Mike Brittle, and Scott Meze (The Davey Tree Expert Company).

Limitations of i-Tree Canopy
The accuracy of the analysis depends upon the ability of the user to correctly classify each point into its correct class. As the number of points increases, the precision of the estimate will increase as the standard error of the estimate will decrease. If too few points are classified, the standard error will be too high to have any real certainty of the estimate.

A Cooperative Initiative Between:

Davey, Arbor Day Foundation, ISA, Casey Trees
i-Tree-Hydro

- Separate GIS program
- Calibrates against stream flow data
### Rock Creek Watershed Area (m²)

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watershed Area (m²)</td>
<td>161,653,500</td>
</tr>
<tr>
<td>Percent Impervious cover</td>
<td>15.8%</td>
</tr>
<tr>
<td>Percent Tree Cover</td>
<td>27%</td>
</tr>
<tr>
<td>Percent of Tree Cover over Impervious Area</td>
<td>10%</td>
</tr>
<tr>
<td>Percent Water Cover</td>
<td>0.3%</td>
</tr>
<tr>
<td>Average Tree Leaf Area Index (LAI)</td>
<td>3.5</td>
</tr>
<tr>
<td>Percent Shrub Cover</td>
<td>7.8%</td>
</tr>
<tr>
<td>Percent Grass Cover</td>
<td>33.8%</td>
</tr>
<tr>
<td>Percent Evergreen Trees</td>
<td>4.2%</td>
</tr>
<tr>
<td>Percent Evergreen Shrubs</td>
<td>21%</td>
</tr>
<tr>
<td>Shrub LAI</td>
<td>3.9</td>
</tr>
<tr>
<td>Leaf on Day</td>
<td>80</td>
</tr>
<tr>
<td>Leaf off Day</td>
<td>294</td>
</tr>
</tbody>
</table>
Hydro Reporting

Current vs. Management Scenario

- Current Total Flow (m³/hr)
- Management Total Flow (m³/hr)
- Current Base Flow (m³/hr)
- Management Base Flow (m³/hr)
- Current Overland Flow (m³/hr)
- Management Overland Flow (m³/hr)
- Current Impervious Flow (m³/hr)
- Management Impervious Flow (m³/hr)
- Rainfall (mm/hr)
i-Tree 2nd Generation

- Growth, Mortality, & Influx Rates
- Tree Cover Maps
  - Landscape change
  - Online Mapping tools
  - Design
  - Forecast
  - Regional Scale

Local Scale
i-Tree 5.0 Tools for Urban Forest Assessment
Now, any questions...